# *Original Research Article*

# RESPONSE OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD CHARACTERISTICS OF OKRA

# ABSTRACT

The present investigation entitled “Response of integrated nutrient management on growth and yield characteristics of okra” was conducted at the Horticultural Research Farm, Sardar Patel University, Balaghat (M. P.) in *Rabi* Season of 2021. In this investigation eight treatments used with control, data pertaining to various criteria used for treatment evaluation were analyzed statistically, the treatments details are T1- Control (No NPK), T2- (100% RDF), T3-(75% RDF + 25% Azospirillum), T4-(50% RDF + 50% FYM), T5- (50% RDF + 50% Vermicompost), T6- (50% RDF + 25% Azospirillum + 25% FYM), T7- (50% RDF + 25% Azospirillum + 25% Vermicompost) and T8 - (50% RDF + 25% FYM + 25% Vermicompost). The experiment was laid out on Randomized Block Design with three replications. The observation of growth and yield of okra crop *i.e.* Plant height (cm) 30 and 60 DAS, Number of leaves per plant 30 and 60 DAS, Number of branches per plant at 60 DAS, Number of internodes per plant, length of internodes, Number of fruits per plant, Fruit length (cm), Weight of fruit per plant (g) and Fruit yield per hectare (q). The result revealed that the outstanding performance was estimated from the treatment no 7 *i.e.* 50% RDF + 25% Azospirillum + 25% Vermicompost, from which maximum estimates were observed for most of the traits *viz.* Plant height (cm) 30 and 60 DAS (21.88 cm and 62.07cm), Number of leaves per plant 30 and 60 DAS (5.60 and 15.58), Number of branches per plant at 60 DAS (6.66), Number of internodes per plant (20.31), length of internodes (9.11 cm), Number of fruits per plant (13.13), Fruit length (16.21cm), Weight of fruit per plant (367.85 g) and Fruit yield per hectare (165.53 q/ha), while the minimum value of all parameters was found under control. From the investigation it has been concluded that combined application of 50% RDF + 25% Azospirillum + 25% Vermicompost was responsible for best results for various growth and yield parameters of okra.

**Key Words:** Okra, INM, FYM, Vermicompost and Azospirillum.**INTRODUCTION**

“Okra [*Abelmoschus esculantus* (L.) Moench] commonly known as lady's finger or bhindi, is one of the most important vegetable crop grown extensively throughout the country during summer and rainy seasons due to its high adaptability over a wide range of environmental conditions. Okra was originated in the Abyssinian centre of origin which includes Ethiopia, the mountainous or plateau portion of Eritrea, and the eastern, higher part of the Anglo Egyptian Sudan” (Swamy 2023).

“Furthermore, improper use of chemical fertilizers causing nutritional imbalance in the soil, instability in productivity and hidden hunger, besides depleting the nutritional quality of the vegetables. To maintain sustainability in quality production through proper use of different sources will also help to maintain the fertility of the soil” (Palaniappan and Annadurai, 2000). “One such alternative is an organic farming that avoids depletion of soil organic matter and plant nutrients besides suppression of some insect-pest and diseases” (Gaur, 2001). “Major components of organic farming are organic manures, biofertilizers, biopesticides. Organic manures not only balance the nutrient supply but also improve the physical and chemical properties of soil. Biofertilizers, which are eco-friendly and more economical can, play an important role in reducing the dependence on chemical fertilizers. They activate beneficial microorganism present in the soil, utilize atmospheric nitrogen for fixation in the soil and improve the availability and uptake of existing nutrients besides exerting other beneficial effects. The main principle of integrated nutrient management is to maximize the use of organic inputs while, minimizing nutrient losses and to make supplementary use of chemical fertilizers. Good practices for integrated nutrient management often involve a combination of organic and inorganic nutrient sources. Organic materials maintain and improve soil productivity, while chemical fertilizers are often needed to increase production. Integrated nutrient management contributes to better farm waste management, minimizes environmental pollution, improves soil productivity, and ensures the production of safe food and feed. The application of different nitrogen levels significantly enhances plant growth by improving plant characteristics” (Jat *et al.,* 2018).

# MATERIALS AND METHODS

#  The present investigation entitled “Response of integrated nutrient management on growth and yield characteristics of okra” was conducted at the Horticultural Research Farm, Sardar Patel University, Balaghat, Madhya Pradesh in *Rabi* Season of 2021. In this experiment eight treatments were used with control, data pertaining to various criteria used for treatment evaluation were analyzed statistically, the treatments details are T1- Control (No NPK), T2- (100% RDF) *i.e.* (100:60:50 kg NPK ha-1), T3-(75% RDF + 25% Azospirillum), T4-(50% RDF + 50% FYM), T5- (50% RDF + 50% Vermicompost), T6- (50% RDF + 25% Azospirillum + 25% FYM), T7- (50% RDF + 25% Azospirillum + 25% Vermicompost) and T8- (50% RDF + 25% FYM + 25% Vermicompost), the experiment was laid out on Randomized Block Design with three replications. The observation of growth and yield of okra crop *i.e.* Plant height (cm) 30 and 60 DAS, Number of leaves per plant 30 and 60 DAS, Number of branches per plant at 60 DAS, Number of internodes per plant, Length of internodes, Number of fruits per plant, Fruit length (cm), Weight of fruit per plant (g) and Fruit yield per hectare (q).

# RESULT AND DISCUSSION

**Plant height (cm) at 30 and 60 DAS**

At the growth stage at 30 and 60 DAS of okra crop, the maximum plant height was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) *i.e.* (21.88 cm and 62.07cm), followed by the treatment T3 (75% RDF + 25% Azospirillum) *i.e.* (20.74 cm, and 61.54 cm), T2 (100% RDF) i.e. (19.94 cm and 61.32 cm) and T5 ((50% RDF + 50% Vermicompost) i.e. (19.84 cm and 61.20 cm), while the minimum plant height at 30 and 60 DAS was observed under the treatment T1 (Control) i.e. (19.21 cm and 57.16 cm. The region behind that the application of organic nutrients along with RDF might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth while the minimum plant growth was due to non-availability of nutrients. Similar findings were reported by Tensingh and Muthulakshmi (2017); Samar (2018); Abbas *et al.,* (2019); Singh and Tiwari (2020); Singh *et al.,* (2021) in Okra.

**Number of leaves per plant at 30 and 60 DAS**

At the growth stage at 30 and 60 DAS of okra crop, the maximum number of leaves per plant was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. (5.60 and 15.58), followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. (5.57 and 15.44), T2 (100% RDF) i.e. (5.32 and 15.25) and T5 (50% RDF + 50% Vermicompost) i.e. (5.19 and 14.84) while the minimum number of leaves per plant at 30 and 60 DAS was observed under the treatment T1 (Control) i.e. (4.31 and 12.31). The application of integrated nutrients might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth enhancing the number of branches and leaves per plant while the minimum plant growth was due to non-availability of nutrients. Similar findings were reported by Adekunle (2013); Tensingh and Muthulakshmi (2017); Samar (2018); Abbas *et al.,* (2019) in Okra.

**Number of branches per plant at 60 DAS**

At the growth stage at 60 DAS of okra crop, the maximum number of branches per plant was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. (6.66), followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. (6.13), T2 (100% RDF) i.e. (6.00), and T5 ((50% RDF + 50% Vermicompost) i.e. (5.92), while the minimum number of branches per plant at 60 DAS was observed under the treatment T1 (Control) i.e. (4.85). The significant interactive effect as a consequence of organic sources and fertilizers are attributed to the favourable nutritional status of the soil resulting into increased biomass production of the crop. This may be attributed to favourable effect of neem cake, vermicompost and biofertilizers on microbial and root proliferation in soil, which caused solubilizing effect on native nitrogen, phosphorus, potassium and other nutrients. Nambiar (1994), suggested that “neither organic manures alone nor exclusive application of chemical fertilizers could achieve the yield sustainability at a high order under modern farming where the nutrient turnover in the soil plant system is quite high. Integrative organic, inorganic and bio-fertilizers were, however, found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production by the synergistic effect of organic sources on improving efficiency of optimum dose of NPK”.

**Number of internodes per plant**

The maximum number of internodes per plant was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. 20.31, followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. 20.00, T2 (100% RDF) i.e. 19.80 and T5 (50% RDF + 50% Vermicompost) i.e. 19.67, while the minimum number of internodes per plant was observed under the treatment T1 (Control) i.e. 17.70. The findings with comparison with Bamboriya *et al.,* (2018), Shani Raj, (2021) and Tensingh (2015). The combination of 50% RDF with 25% Azospirillum and 25% vermicompost (T7) provides a balanced nutrient supply, enhancing root development and nutrient uptake. This integrated approach leads to increased internode formation, corroborating findings from previous research on the benefits of combining organic and inorganic fertilizers with biofertilizers in okra cultivation.

**Length of nodes per plant (cm)**

The maximum length of nodes per plant was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. 9.11 cm, followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. 8.78 cm and followed by the treatment T2 (100% RDF) i.e. 8.43 cm and T5 (50% RDF + 50% Vermicompost) i.e. 8.22 cm, while the minimum length of nodes per plant was observed under the treatment T1 (Control) i.e. 6.33 cm.

**Number of fruits per plant**

The maximum number of fruits per plant was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. 13.33, followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. 12.32 and followed by the treatment T2 (100% RDF) i.e. 12.01 and T5 (50% RDF + 50% Vermicompost) i.e. 11.55, while the minimum number of fruits per plant was observed under the treatment T1 (Control) i.e. 8.98.

**Fruit length (cm)**

 The maximum fruit length and width was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. (16.21 cm), followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. (15.45 cm), T2 (100% RDF) i.e. (15.00 cm) and T5 (50% RDF + 50% Vermicompost) i.e. 14.83 cm, while the minimum fruit length and width was observed under the treatment T1 (Control) i.e. (11.45 cm). Integrated Nutrient Management (INM) significantly enhances okra yields and fruit characteristics. By combining organic and inorganic fertilizers, INM ensures a balanced nutrient supply, promoting healthy plant growth and increased yield per plant. It supports longer fruit length and larger diameters due to improved cell expansion and development. Additionally, INM enhances fruit weight, resulting in more substantial okra pods. This holistic approach enhances overall crop health, reduces nutrient imbalances, and minimizes environmental impact, ultimately leading to improved okra production and quality. Similar findings were reported by Sundari and Gandhi (2013); Sharma *et al.,* (2014); Miglani *et al.,* (2017); Bamboriya *et al.,* (2018); Samar (2018); Devanda *et al.,* (2021) Mishra *et al.* (2021), Paul *et al.* (2022) and Tendulkar *et al.* (2023) in Okra.

**Weight of fruit per plant (g)**

 The maximum weight of fruit per plant was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. (367.85 g), followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. (318.02 g) and followed by the treatment T2 (100% RDF) i.e. (297.62 g) and T5 (50% RDF + 50% Vermicompost) i.e. (284.26 g), while the minimum weight of fruit per plant (g) was observed under the treatment T1 (Control) i.e. (179.45 g ).

**Fruit yield per hectare (q)**

The maximum fruit yield per hectare (q) was observed under the treatment T7 (50% RDF + 25% Azospirillum + 25% Vermicompost) i.e. 165.53 q/ha, followed by the treatment T3 (75% RDF + 25% Azospirillum) i.e. 143.11 q/ha and followed by the treatment T2 (100% RDF) i.e. 133.93 q/ha and T5 (50% RDF + 50% Vermicompost) i.e. 127.92 q/ha, while the minimum weight of fruit per plot was observed under the treatment T1 (Control) i.e. 80.75 q/ha. A significant increase in yield and yield parameters in okra with integrated nutrient application may be due to vigorous vegetative growth and increased chlorophyll content, which together accelerate the photosynthetic rate and thereby increase the supply of carbohydrate to plants. The beneficial role of supplemented organic manures and biofertilizers in improving soil physical, chemical and biological properties is well known, which in turn helps in better nutrient absorption by plants and resulting higher yield. There are also several researchers such as Mirdudkar *et al.* (2018), Mishra *et al.* (2021), Paul *et al.* (2022) and Tendulkar *et al.* (2023) which reported that inclusion of organic manure as well as organic fertilizers in the plant nutrition is helping to enhance the yield of okra.

**CONCLUSION**

 The present study highlights the effectiveness of integrated nutrient management (INM) in improving the growth, yield and quality of okra. The combined application of 50% RDF + 25% Azospirillum + 25% Vermicompost (T7) consistently produced the best results across various growth and yield parameters.

**Disclaimer (Artificial intelligence)**

**1:**

**Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.**

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**Table 1: Response of integrated nutrient management on growth parameters of okra at different growth stages**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Plant height (cm)** | **Number of leaves per plant** | **Number of branches per plant** | **Number of internodes per plant** | **Length of nodes per plant (cm)** |
| **30 DAS** | **60 DAS** | **30 DAS** | **60 DAS** | **60 DAS** |
| T1 | 19.21 | 57.16 | 4.31 | 12.31 | 4.85 | 17.70 | 6.33 |
| T2 | 19.94 | 61.32 | 5.32 | 15.25 | 6.00 | 19.80 | 8.43 |
| T3 | 20.73 | 61.54 | 5.57 | 15.44 | 6.13 | 20.00 | 8.78 |
| T4 | 19.39 | 57.27 | 4.88 | 13.06 | 5.69 | 19.38 | 7.10 |
| T5 | 19.84 | 61.20 | 5.19 | 14.84 | 5.92 | 19.67 | 8.22 |
| T6 | 19.49 | 58.40 | 5.01 | 14.00 | 5.85 | 19.65 | 7.32 |
| T7 | 21.88 | 62.07 | 5.60 | 15.58 | 6.66 | 20.31 | 9.11 |
| T8 | 19.63 | 59.16 | 5.49 | 14.39 | 5.87 | 19.46 | 7.65 |
| **S.Em.±** | **0.0256** | **0.0579** | **0.0125** | **0.0340** | **0.0146** | **0.0226** | **0.0270** |
| **CD at (5%)** | **0.078** | **0.176** | **0.038** | **0.103** | **0.044** | **0.069** | **0.082** |

**Table 2: Response of integrated nutrient management on yield parameters of okra**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Number of fruits per plant** | **Fruit length (cm)** | **Weight of fruit (g)** | **Weight of fruit per plant (g)** | **Fruit yield per hectare (q)** |
| T1 | 8.98 | 11.45 | 19.95 | 179.45 | 80.75 |
| T2 | 12.01 | 15.00 | 24.74 | 297.62 | 133.93 |
| T3 | 12.32 | 15.45 | 25.77 | 318.02 | 143.11 |
| T4 | 11.05 | 13.33 | 22.71 | 251.36 | 113.11 |
| T5 | 11.55 | 14.83 | 24.57 | 284.26 | 127.92 |
| T6 | 11.18 | 14.05 | 23.01 | 257.68 | 115.96 |
| T7 | 13.33 | 16.21 | 27.55 | 367.85 | 165.53 |
| T8 | 11.38 | 14.41 | 24.53 | 279.62 | 125.83 |
| **S.Em.±** | **0.0361** | **0.0421** | **0.065** | **3.151** | **1.4181** |
| **CD at (5%)** | **0.110** | **0.128** | **0.198** | **9.558** | **4.301** |